No 30.

THE
Sidereal Messenger.

Conducted by Wm. W. PAYNE,

Director of Carleton College Observatory.

DECEMBER, 1884.

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"He telleth the number of the stars; He calleth them all by their names."

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XUM

The Sidereal Messenger.

Conducted by Wm. W. PAYNE, Director of Carleton College Observatory, Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 3. No. 10. DECEMBER, 1884. WHOLE No. 30.

PENDING PROBLEMS OF ASTRONOMY.*

[*Continued from page 266.*]

There can be no question, that it is now one of the most important and pressing problems of observational astronomy to devise apparatus and methods delicate enough to enable the student to follow promptly and accurately the presumable changes in the daily, even the hourly, amounts of the solar radiation. It might, perhaps, be possible with existing instruments to obtain results of extreme value from observations kept up with persistence and scrupulous care for several years at the top of some rainless mountain, if such can be found; but the undertaking would be a difficult and serious affair, quite beyond any private means.

Related to this subject is the problem of the connection between the activity of the solar surface and magnetic disturbances on the earth,—a connection unquestionable as matter of fact, but at present unexplained as matter of theory. It may have something to do with the remarkable prominence of iron in the list of solar materials; or the explanation may, perhaps, be found in the mechanism by

*From an address to the American association for the advancement of science at Philadelphia, Sept. 5, 1884, by Prof. C. A. YOUNG, of Princeton, retiring president of the association.

means of which the radiations of light and heatr traverse interplanetary space, presenting itself ultimately as a corollary of the perfected electro-magnetic theory of light.

The chromosphere and prominences present several problems of interest. One of the most fruitful of them relates to the spectroscopic phenomena at the base of the chromosphere, and especially to the strange differences in the behavior of different spectrum-lines, which, according to terrestrial observations, are due to the same material. Of two lines (of iron, for instance) side by side in the spectrum, one will glow and blaze, while the other will sulk in imperturbable darkness; one will be distorted and shattered, presumably by the swift motion of the iron vapor to which it is due, while the other stands stiff and straight.

Evidently there is some deep-lying cause for such differences; and as yet no satisfactory explanation appears to me to have been reached, though much ingenious speculation has been expended upon it. Mr. LOCKYER'S bold and fertile hypothesis, already alluded to, that at solar and stellar temperatures our elements are decomposed into others more elemental yet, seems to have failed of demonstration thus far, and rather to have lost ground of late; and yet one is almost tempted to say, "It *ought* to be true," and to add that there is more than a possibility that its essential truth will be established some time in the future.

Pobably all that can be safely said at present is, that the spectrum of a metallic vapor (iron, for instance, as before) depends not only upon the chemical element concerned, but also upon its physical conditions; so that, at different levels in the solar atmosphere, the spectrum of the iron will differ greatly as regards the relative conspicuousness of different lines; and so it will happen, that, whenever any mass of iron vapor is suffering disturbance, those lines only which particularly characterize the spectrum of iron in that special statss will be distorted or reversed, while all their sisters will remain serene.

The problem of the solar corona is at present receiving much attention. The most recent investigations respecting

it—those of Dr. HUGGINS and Professor HASTINGS—tend in directions which appear to be diametrically opposite. Dr. HUGGINS considers that he has succeeded in photographing the corna inn full sunshine, and so in establishing its objective reality as an immense solar appendage, sub-permanent in form, and rotating with the globe to which it is attached. One may call it 'an atmosphere,' if the word is not to be too rigidly interpreted. I am bound to say that plates which he has obtained do really show just such appearances as would be produced by such a solar appendage, though they are very faint and ghost-like. I may add further, that, from a letter from Dr. HUGGINS, recently received, I learn that he has been prevented from obtaining any similar plates in England this summer by the atmospheric haze, but that Dr. WOODS, who has been provided with a similar apparatus, and sent to the Riffelberg in Switzerland, writes that he has 'an assured success.'

Our American astronomer, on the other hand, at the last eclipse (in the Pacific Ocean), observed certain phenomena which seem to confirm a theory he had formulated some time ago, and to indicate that the lovely apparition is an apparition only, a purely optical effect due to the *diffraction* (not refraction, nor reflection either) of light at the edge of the *Moon*—no more a solar appendage than a rainbow or a mock sun. There are mathematical considerations connected with the theory which may prove decisive when the paper of its ingenious and able proposer comes to be published in full. In the mean time it must be frankly conceded that the observations made by him are very awkward to explain on any other hypothesis.

Whatever may be the result, the investigation of the status and possible extent of a nebulous envelope around a sun or a star is unquestionably a problem of very great interest and importance. We shall be compelled, I believe, as in the case of comets, to recognize other forces than gravity, heat, and ordinary gaseous elasticity, as concerned in the phenomena. As regards the actual existence of an extensive gaseous envelope around the *Sun*, I may add

that other appearances than those seen at an eclipse seem to demonstrate it beyond question,—phenomena such as the original formation of clouds of incandescent hydrogen at high elevations, and the forms and motions of the loftiest prominences.

But of all solar problems, the one which excites the deepest and most general interest is that relating to the solar heat, its maintenance and its duration. For my own part, I find no fault with the solution proposed by HELMHOLTZ, who accounts for it mainly by the slow contraction of the solar sphere. The only objection of much force is, that it apparently limits the past duration of the solar system to a period not much exceeding some twenty millions of years; and many of our geological friends protest against so scanty an allowance. The same theory would give us, perhaps, half as much time for our remaining lifetime; but this is no objection, since I perceive no reason to doubt the final cessation of the *Sun's* activity, and the consequent death of the system. But while this hypothesis seems fairly to meet the requirements of the case, and to be a necessary consequence of the best knowledge we can obtain as to the genesis of our system and the constitution of the *Sun* itself, it must, of course, be conceded that it does not yet admit of any observational verification. No measurements within our power can test it, so far as we can see at present.

It may be admitted, too, that much can be said in favor of other theories; such as the one which attributes the solar heat to the impact of meteoric matter, and that other most interesting and most ingenious theory of the late Sir WILLIAM SIEMENS.

As regards the former, however, I see no escape from the conclusion, that, if it were exclusively true, the earth ought to be receiving, as was pointed out by the late Professor PEIRCE, as much heat from meteors as from the *Sun*. This would require the fall of a quantity of meteoric matter,—more than sixty million times as much as the best estimates make our present supply, and such as could not

escape the most casual observation, since it would amount to more than one hundred and fifty* tons a day on every square mile.

As regards the theory of SIEMENS, the matter has been, of late, so thoroughly discussed, that we probably need spend no time upon it here. To say nothing as to the difficulties connected with the establishment of such a far-reaching vortex as it demands, nor of the fact that the temperature of the *Sun's* surface appears to be above that of the dissociation point of carbon compounds, and hence above the highest heat of their combustion, it seems certainly demonstrated, that matter of the necessary density could not exist in interplanetary space without seriously affecting the planetary motions by its gravitating action as well as by its direct resistance; nor could the stellar radiations reach us, as they do, through a medium capable of taking up and utilizing the rays of the *Sun* in the way this theory supposes.

And yet I imagine that there is a very general sympathy with the feeling that led to the proposal of the theory,—an uncomfortable dissatisfaction with received theories, because they admit that the greater part of the *Sun's* radiant energy is, speaking from a scientific point of view, simply wasted. Nothing like a millionth part of the sky, as seen from the sun, is occupied, so far as we can make out, by objects upon which its rays can fall; the rest is vacancy. If the *Sun* sends out rays in all directions alike, not one of them in a million finds a target, or accomplishes any useful work, unless there is in space some medium to utilize the

* In an article on astronomical collisions, published in the *North American Review* about a year ago, I wrongly stated the amount at fifty tons. There was some fatality connected with my calculations for that article. I gave the amount of heat due to the five hundred tons of meteoric matter which is supposed to fall daily on the earth with an average velocity of fifteen miles per second as fifty-three calories annually per square metre,—a quantity two thousand times too great. Probably the error would have been noticed if even the number given had not been so small, compared with the solar heat, as fully to justify my argument, which is only strengthened by the correction. I owe the correction to Professor LeConte of California, who called my attention to the errors.

rays, or unknown worlds of which we have no cognizance beyond the stars.

Now, for my own part, I am very little troubled by accusations of wastefulness against nature, or by demands for theories which will show what the human mind can recognize as "use" for all energy expended. Where I can perceive such use, I recognize it with reverence and gratitude, I hope; but the failure to recognize it in other cases creates in my mind no presumption against the wisdom of nature, or against the correctness of an hypothesis otherwise satisfactory. It merely suggests human limitations and ignorance. How can one without sight understand what a telescope is good for?

At the same time, perhaps we assume with a little too much confidence, that, in free space, radiation does take place equally in all directions. Of course, if the received views as to the nature and conduct of the hypothetical "ether" are correct, there is no possibility of questioning the assumption; but, as Sir JOHN HERSCHEL and others have pointed out, the properties which must be ascribed to this "ether," to fit it for its various functions, are so surprising and almost inconceivable, that one may be pardoned for some reserve in accepting it as a finality. At any rate, as a fact, the question is continually started (the idea has been brought out repeatedly, in some cases by men of real and recognized scientific and philosophic attainment), whether the constitution of things may not be such that radiation and transfer of energy can take place only between ponderable masses; and that, too, without the expenditure of energy upon the transmitting-agent (if such exist) along the line of transmission, even *in transitu*. If this were the case, then, the *Sun* would send out its energy only to planets and meteors and sister-stars, wasting none in empty space; and so its loss of heat would be enormously diminished, and the time-scale of the life of the planetary system would be correspondingly extended. So far as I know, no one has ever yet been able to indicate any kind of medium or mechanism by which vibrations,

such as we know to constitute the radiant energy of light and heat, can be transmitted at all from *Sun* to planet under such restrictions, Still one ought not to be too positive in assertions as to the real condition and occupancy of so-called vacant space. The "ether" is a good working hypothesis, but hardly more as yet.

I need not add, that a most interesting and as yet inaccessible problem, connected with the preceding, is that of the mechanism of gravitation, and, indeed, of all forces that seem to act at a distance: as for that matter, in the last analysis, *all* forces do. If there really be an "ether," then it would seem that somehow all attractions and repulsions of ponderable matter must be due to its action. CHALLIS's investigations and conclusions as to the effect of hydrodynamic actions in such a medium do not seem to have commanded general acceptance; and the field still lies open for one who will show how gravitation and other forces can be correlated with each other through the ether.

Meteors and the comets, seeming to belong neither to the solar system nor to the stellar universe, present a crowd of problems as difficult as they are interesting. Much has undoubtedly been gained during the last few decades, but in some respects that which has been learned has only deepened the mystery.

The problem of the origin of comets has been supposed to be solved to a certain extent by the researches of SCHIAPARELLI, HEIS, Professor NEWTON, and others, who consider them to be strangers coming in from outer space, sometimes "captured" by planets, and forced into elliptic orbits, so as to become periodic in their motion. Certainly this theory has strong supports and great authority, and probably it meets the conditions better than any other yet proposed. But the objections are really great, if not insuperable,—the fact that we have so few, if any, comets moving in hyperbolic orbits, as comets *met* by the *Sun* would be expected to move; that there seems to be so little relation between the direction of the major axes of cometary orbits and the direction of the solar motion in space;

and especially the fact, pointed out and insisted upon by Mr. PROCTOR in a recent article, that the alteration of a comet's natural parabolic orbit to the observed elliptic one, by planetary action, implies a reduction of the comet's velocity greater than can be reasonably explained. If, for instance, BRORSEN'S comet (which has a mean distance from the *Sun* a little more than three times that of the earth) was really once a parabolic comet, and was diverted into its present path by the attraction of *Jupiter*, as generally admitted, it must have had its velocity reduced from about eleven miles a second to five. Now, it is very difficult, if not out of the question, to imagine any possible configuration of the two bodies and their orbits which could result in so great a change. While I am by no means prepared to indorse as conclusive all the reasoning in the article referred to and should be very far from ready to accept the author's alternative theory (that the periodic comets have been ejected from the planets, and so are not their captives, but their children), I still feel that the difficulty urged against the received theory is very real, and not to be evaded, though it may possibly be overcome by future research.

Still more problematical is the constitution of these strange objects of such enormous volume and inconceivable tenuity, self-luminous and transparent, yet reflecting light, the seat of forces and phenomena unparalleled in all our other experience. Hardly a topic relating to their appearance and behavior can be named which does not contain an unsolved problem. The varying intensity, polarization, and spectroscopic character of their light; the configurations of the nucleus and its surrounding nebulosity; and especially the phenomena of jets, envelopes and tail,—all demand careful observation and thorough discussion.

I think it may be regarded as certain, that the explanation of those phenomena when finally reached, if that time ever comes, will carry with it, and be based upon, an enormous increase in our knowledge as to the condition, contents, and temperature of inter-planetary space, and the be-

havior of matter when reduced to lowest terms of density and temperature.

Time forbids any adequate discussion of the numerous problems of stellar astronomy. Our work, in its very nature incessant and interminable, consists, of course, in the continual observation and cataloguing of the places of the stars, with ever-increasing precision. The star-places form the scaffold and frame-work of all other astronomical investigations involving the motions of the heavenly bodies; they are the reference-points and bench-marks of the universe. Ultimately, too, the comparison of catalogues of different dates will reveal the paths and motions of all the members of the starry host, and bring out the great orbit of the *Sun* and his attendant planets.

Meanwhile, micrometric observations are in order, upon the individual stars in different clusters, to ascertain the motions which occur in such a case; and the mathematician is called upon again to solve the problem of such movement.

Now, too, since the recent work of GILL and ELKIN in South Africa, and of STRUVE, HALL, and others, elsewhere, upon stellar parallax, new hopes arise that we may soon come to some wider knowledge of the subject; that, instead of a dozen or so parallaxes of doubtful precision, we may get a hundred or more relating to stars of widely different brightness and motion, and so be enabled to reach some trustworthy generalizations as to the constitution and dimensions of the stellar universe, and the actual rates of stellar and solar motion in space.

Most interesting, also, are the studies now so vigorously prosecuted by Professor PICKERING in this country, and many others elsewhere, upon the brightness of the stars, and the continual variations in this brightness. Since 1875, stellar photometry has become almost a new science.

Then, there are more than a myriad of double and multiple stars to watch, and their orbits to be determined; and the nebulæ claim keen attention, since some of them appear to be changing in form and brightness, and are likely

to reveal to us some wonderful secrets in the embryology of worlds.

Each star also presents a subject for spectroscopic study; for although, for the most part, the stars may be grouped into a very few classes from the spectroscopic point of view, yet, in detail, the spectra of objects belonging to the same group differ considerably and significantly, almost as much as human faces do.

For such investigations, new instruments are needed, of unexampled powers and accuracy, some for angular measurement, some for mere power of seeing. Photography comes continually more and more to the front; and the idea sometimes suggests itself, that by and by the human eye will hardly be trusted any longer for observations of precision, but will be superseded by an honest, unprejudiced, and unimaginative plate and camera. The time is not yet, however, most certainly. Indeed, it can never come at all, as relates to certain observations; since the human eye and mind together integrate, so to speak, the impressions of many separate and selected moments into one general view, while the camera can only give a brutal copy of an unselected state of things, with all its atmospheric and other imperfections.

New methods are also needed, I think (they are unquestionably possible), for freeing time-observations from the errors of personal equation; and increased precision is demanded, and is being progressively attained, in the prevention, or elimination, of instrumental errors, due to differences of temperature, to mechanical strains, and to inaccuracies of construction. Astronomers are now coming to the investigation of quantities so minute, that they would be completely masked by errors of observation that formerly were usual and tolerable. The science has reached a stage, where, as was indicated at the beginning of this address, it has to confront and deal with the possible unsteadiness of the earth's rotation, and the instability of its axis. The astronomer has now to reverse the old maxim of the court, for him, and most emphatically at present,

de minimis curat lex. Residuals and minute discrepancies are the seeds of future knowledge, and the very foundations of new laws.

And now, in closing this hurried and inadequate, but I fear rather tedious, review of the chief problems that are at present occupying the astronomer, what answer can we give to him who insists, *Cui bono?* and requires a reason for the enthusiasm that makes the votaries of our science so ardent and tireless in its pursuit? Evidently very few of the questions which have been presented have much to do directly with the material welfare of the human race. It may possibly turn out, perhaps, that the investigation of the solar radiation, and the behavior of Sun-spots, may lead to some better understanding of terrestrial meteorology, and so aid agricultural operations and navigation. I do not say it will be so,—in fact, I hardly expect it,—but I am not sure it will not. Possibly, too, some few other astronomical investigations may facilitate the determination of latitudes and longitudes, and so help exploration and commerce; but, with a few exceptions, it must be admitted that modern astronomical investigations have not the slightest immediate commercial value.

Now, I am not one of those who despise a scientific truth or principle because it admits of an available application to the affairs of what is called "practical life," and so is worth something to the community in dollars and cents: its commeraial value is—just what it is—to be accepted gratefully.

Indirectly, however, almost all scientific truth has real commercial value, because "knowledge is power," and because (I quote it not irreverently) "the truth shall make you free,"—any truth, and, to some extent; that is to say, the intelligent and intellectually cultivated will generally obtain a more comfortable livelihood, and do it more easily, than the stupid and the ignorant. Intelligence and brains are most powerful allies of strength and hands in the struggle for existence; and so, on purely economical grounds, all kinds of science are worthy of cultivation.

But I should be ashamed to rest on this lower ground: the highest value of scientific truth is not economic, but different and more noble; and to a certain and great degree, its truest worth is more as an object of pursuit than of possession. The "practical life"—the eating and the drinking, the clothing and the sheltering—comes *first*, of course, and the necessary foundation of any thing higher; but it is not the whole or the best or the most of life. Apart from all spiritual and religious considerations, which lie one side of our relations in this association, there can be no need, before this audience, to plead the higher rank of the intellectual, aesthetic, and moral life above the material, or to argue that the pabulum of the mind is worth as much as food for the body. Now, it is unquestionable, that, in the investigation and discovery of the secrets and mysteries of the heavens, the human intellect finds most invigorating exercise, and most nourishing and growth-making aliment. What other scientific facts and conceptions are more effective in producing a modest, sober, truthful, and ennobling estimate of man's just place in nature, both of his puny insignificance, regarded as a physical object, and his towering spirit, in some sense comprehending the universe itself, and so akin to the divine?

A nation oppressed by poverty, and near to starving, needs first, most certainly, the trades and occupations that will feed and clothe it. When bodily comfort has been achieved, then higher needs and wants appear; and then science, for truth's own sake, comes to be loved and honored along with poetry and art, leading men into a larger, higher, and nobler life.

Professor Hugo Glynden, Director of the Observatory at Stockholm, Sweden, and well known for his studies during recent years of the eight great planets, has been offered, and has accepted, the Professorship of Astronomy at the Gottingen University.—*Nature.*

THE LICK OBSERVATORY.

PROFESSOR E. S. HOLDEN.

It may be of interest to give a brief account of recent work at the Lick Observatory. It is difficult to convey an adequate idea of the excellence of the site, and of the thorough way in which the Observatory has been constructed by the Lick trustees without the aid of illustrations.

The most recent addition to the observatory is an exquisite meridian-circle by the REPSOLD'S, of Hamburg, and the house to contain it.

The meridian-circle house is forty feet square, with the walls double throughout. The inner wall is of California redwood, which is almost incombustible, and beyond this is an air-space of 24 inches completely round the building, on the north side as well as on the others. The outer frame carries a louvre work of galvanized iron which completely prevents the *Sun* from striking any part of the building proper. The ceiling is flat, of wood, and a very large air-space communicates with the room itself through wire netting which covers the sides of the slit. Complete access to any part of the air-spaces, both of the walls and of the roof is provided. On the west, the room opens into a ventilating tower, two stories in height, which also adjoins, and is connected with the house for the meridian-transit instrument, which lies still further to the west. The design of this construction, is to keep the temperature of the two houses and of their air-spaces precisely the same, as that of the external air, and it is probable that this object has been practically attained. The new REPSOLD meridian-circle, which has just been mounted, is of six (French) inches aperture, and is essentially of the same design as the meridian circle of Strassburg, and of the smaller circles of Williamstown and Madison.

It has north and south collimators of six inches aperture,

and an east and west collimator of three inches. The three six-inch objectives were made by ALVAN CLARK & SONS.

There are two circles, each divided to two minutes, and read by four microscopes (magnifying forty diameters) to one second.

Two extra microscopes of seventy diameters serve for the determination of the division-errors. One of the circles is fixed to the axis, and will serve first as a setting circle, so that the same setting will always hold good for the same object, which is a great convenience, and secondly, this fixed circle will serve for star observations in the usual manner. The other circle is movable around the axis by a wheel and pinion. It will serve for fundamental observations when the division-errors of each one-degree mark and the errors of the two-minute marks for four single degrees, ninety degrees apart are once determined. It can also be used to eliminate the accidental division-errors, by turning it each day through some number of minutes, as 7, 11, 13, etc., so that successive observations of the same star will fall on different divisions. The complete division of the two circles, also allows of a determination of the flexure of the circles, etc. The large size of the collimator objectives, permit the pointing of one collimator, on the other with a precision equal to that of the pointing of the telescope on the collimators, and will serve for very precise determinations of the horizontal flexure. Complete provision is also made for reflection observations. A *mire*, or meridian mark eighty feet distant, may eventually replace the south collimator, whose objective is to be fitted to an equatorial mounting, also by REPSOLD. A *mire* may also be mounted some eighty feet west of the circle, on a pier within the main building. Altogether this circle is the most perfect of its class in the United States, if not in the world. It has been inspected by Prof. AUWERS and Dr. KRUEGER, and pronounced by them to be satisfactory in all particulars. Its site is especially good. The elevation above the sea is 4200 feet, and for six or seven months of the year, every night is clear. Half of the remainder of

the time is also clear. It is plain that especial advantages will follow from a site which permits of continuous observations. The piers are built in the most substantial manner, of hard brick laid in cement, and their foundations are to be enclosed in air-tight boxes. The astronomical advantages of this perfect instrument, mounted in such a site, in so careful a manner, can not be over estimated. The construction of this meridian-circle house, of a double-house for the observers, and the finishing of the interior of the main building have occupied the whole of this season.

The entire observatory may be said to be complete with the exception of the 36-inch equatorial and of the dome to contain it. The flint disk for the objective of the 36-inch has long been completed. The crown disk has presented unexpected difficulties, no less than nineteen unsuccessful disks having been cast. It is hoped that a perfect disk may be had in a few months, and that the whole objective will be made and mounted in 1887 or 1888. The construction of the dome and of the mounting will be proceeded with as soon as the crown disk is successfully cast. The observatory is now a very complete one, possessing as it does a 12-inch equatorial, a 4-inch transit, a comet seeker, a 6-inch meridian-circle and a photoheliograph, as well as a REPSOLD vertical-circle and a 6-inch equatorial. The main building is practically complete and is perfectly adapted to its uses. Five very excellent clocks (by HOHWU, DENT, C. FRODSHAM and HOWARD), and set of chronometers by NEGUS will soon be available. The beginnings of a large astronomical library have been made. A complete electrical system has been put in for connecting clocks, chronographs, etc., and there are only a few observatories in the world which are in better condition for astronomical work than the Lick observatory now is, even without its chief instrument—the 36-inch refractor.

Minor Planet No. 241 is named *Germania*. It has been erroneously published as the name of planet number 242.

THE MESSENGER FOR 1885.

THE EDITOR.

Our readers may have notice that this number completes volume three of the MESSENGER. Hereafter each volume will begin with January of successive years and contain, at lease, ten numbers of 32 pages each as herebore. As in the past, the MESSENGER will be conducted by ourselves, and in the same general form, but, it is hoped, with improved mechanical execution. Arrangements looking to this end are now being carefully considered and added facilities will be certainly secured. As we are to be relieved in the future of nearly all responsibility in details belonging to the duties of publisher, attention can and will be given to desired changes and more variety in the editorial work.

In this department one thing is clear and certain, that an astronomical journal, to be worthy of the name, must maintain a scientific character worthy of the attention and support of the leading workers in astronomy in this or in any other country. If there is need or call for such a publication, it will receive the support necessary to maintain it provided its scientific character is what it should be. We are aware that in holding the general line of our work closely to this idea of scientific and practical usefulness, we have failed to interest hundreds of people who would read, enjoy and liberally support a publication in the interest of astronomy that was chiefly popular and unscientific. The great number of letters received every month asking for specimen copies of the MESSENGER is a safe index of the popular interest in astronomy, the oldest and the grandest branch in the whole circle of the sciences. In view of this widespread interest in the popular side of our science it is thought wise to devote a few pages in each number of the next volume to a popular summary of late and fresh work in astronomy adapted to the easy comprehension of common readers and students, many of whom

have expressed a desire for aid of this kind in pursuing their studies.

On account of the limited space that can be given to any one feature of our work, it may be proper to remind the many friends who may desire to contribute such matter to the MESSENGER, that it should be prepared to occupy as small space as possible consistent with precision and clearness of expression. Variety of matter in paragraph form is especially desired. Attention will be given to queries concerning the facts and theories of astronomy that may be deemed helpful to students, amateurs and teachers. This kind of interchrnge of thought ought to be a valuable stimulant to endeavor as well as a fresh source of useful information for guidance in work or study. The student of astronomy who is determined to think and to work out things for himself, by such aids as these, and in such ways as will thus be easily opened to him, need not fear that his time will be wasted, or thrown away, or that meager returns will be the result of diligent endeavor. The person that is prepared and ready for good work in almost any department of astronomy will very soon find enough work to do with fair remuneration. The kind of work in this science now most needed is something more than that which is derived from books, even in college or public school. To understand the physical facts some observation at least should accompany almost every branch of work. Very small and inexpensive instruments are always useful, if the larger ones cannot be afforded. The great body of ordinary astronomical work, as well as most of the discoveries in all parts of the world, has been made by small telescopes or other common instruments down to and including the common opera-glass.

With such facts before the student or amateur astronomer it would seem only fair to say, that the limitations which are placed on the career of any fair mind with a firm purpose to succeed are those only which are self-imposed and self-determined, when that purpose is made solid in the wisdom and love of a Divine Being.

On The Original Graduation of the Harvard College Meridian Circle in Situ.—Professor W. A. Rogers.*

In the ordinary method of discussing the errors of graduation in a meridian circle, it is assumed that the graduated arc retains its original form throughout the revolution of the telescope. It is certain that this constancy of form is not maintained in the Harvard College meridian circle and it is probable that in all instruments of this class, with the possible exception of the later instruments of REPSOLD, more or less *irregular* flexure of the circles occur. In so far as the bending is symmetrically distributed, an elimination of the error thus produced is effected, but any change of form at unknown points in the arc of revolution will not only tend to vitiate any system of errors derived from observed measures of given subdivisions, but may actually introduce the very class of errors which it is the aim to eliminate.

It is therefore a matter of supreme importance that some method of investigating the errors of a meridian circle shall be devised which does not depend upon unknown variations in the form of the circle whose errors are desired. This necessity is emphasized by the outstanding systematic differences which, at the present time, exist between the observations in declination made at the principal observatories of the world. The maximum amount of this difference is about five times as great as *the probable error of a single observation.* That is, assuming that *e. g.* the declination of a star at 20° south, as observed at Greenwich, is correct, the observation of the same star at Pulkowa will have an error at least five times as great as a skillful observer ought to make in a single observation, on the supposition that his result is affected by accidental errors of observation only. It is doubtless true that the larger share of these outstanding differences is due to errors in the refraction tables employed for low altitudes, but a certain portion are certainly due to errors of graduation augmented by those errors of flexure and eccentricity of

*Read before the Philadelphia meeting of the A. A. A. S.

pivots which are not eliminated by the employment of four microscopes. Until each of these errors has been determined it is useless to attempt the determination of the errors of the refraction tables. In the present paper, an attempt has been made to refer the subdivisions of the graduated circle to a constant unit which is independent of the subdivision to be investigated.

The success which has attended the use of the electro-magnet clamps in the dividing engine constructed for the writer at the Waltham watch factory, suggested the application of the same principle to the investigation of the errors of a meridian circle, and to the feasibility of the graduation of the circle *in situ*, if this investigation should be successful. In this engine, is an arm which at one end moves between two stops, one of which is movable, the other end rests upon the cylindrical shoulder of the screw which is to receive equal increments of revolution.

Two magnets are attached to this arm, the cores of which are fitted to the curvature of the index circle of the screw. A third magnet of similar construction is attached to the bed-plate of the machine, and independent of the arm. When the two upper magnets are in circuit, the arm becomes firmly attached to the index without the slightest disturbance of position, and the index is carried forward the required amount by moving the arms between the two stops. During the upward motion of the arm the lower magnet holds the index while the two upper magnets are free, thus allowing the arm to make contact to the two upper stops in preparation for the next downward stroke.

It has been found from experiment that under similar conditions as many as 5,000 movements of the arm will in repeated trials give the same arc of revolution. It did not, therefore, seem too much to expect that the same method might be successfully applied to the movement of a meridian circle over equal arcs of revolution under exactly the conditions which prevail in actual work with the instrument. It was therefore determined to try the method with the meridian circle of Harvard College Observatory.

Professor PICKERING kindly authorized the expense of the construction of the necessary apparatus, which was designed by Mr. GEO. B. CLARK, of the firm of ALVAN CLARK & SONS, and which was made under his superintendence.

A ring having an outside face of two inches was made in two halves and securely fastened to the axis of the telescope. The magnet arm was made in such a manner that the only connection with the ring was made by the contact of the cores of the magnets at the periphery of the ring. A very heavy bed-plate of iron was securely clamped to the marble pier in such a manner that the edge might be made perpendicular to the axis of rotation and at a distance of about five feet from the center of the axis. The stops are heavy plates of iron with projecting oval surfaces of tempered steel which move along this table, and which are held in position by heavy clamping screws. They are arranged for a movement of the telescope over arcs varying between 0° and 30°. With the aid of the graduated circle of the telescope it is found easy to set the stops quickly and accurately by tapping the stop-plates with a light hammer.

It was found that a bichromate battery of six cells was sufficient to clamp the magnet-arm securely to the ring.

It will be at once understood that unless the ring upon which the magnet-arm rests is truly circular, the arm will rise and fall with the revolution of the telescope, thus giving rise to periodic errors proportional in amount to the deviation of the periphery of the ring from a true circle. The test of this circular form was made by means of a microscope attached to the iron bed-plate with which the movement of the arm vertically was observed and measured, a graduated polished metal plate being clamped to the arm for this examination. It was found that during one-half of the revolution of the telescope very little motion of the arm could be detected, but that during the remaining half the maximum rise of the arm amounted to about $\frac{1}{20}$ mm. As would be expected the chief part of the disturbance occurred at those points at which the magnets passed the junction of the two halves of the ring.

It does not seem advisable to encumber this paper with the details of the observations which were made with the ring in its original form. An attempt was made to compare the 30° divisions of the graduated circle by a reference to the fixed distance between the stops, four microscopes being read for each contact, with the expectation that the effect of the error in the form of the ring could be measured by means of a microscope of high power which should measure directly the accumulated error of the arc of revolution at the contact points for each arc of 30°. It will be seen that this expectation was not realized for the summed series of errors of the 30° points of the circle.

From seven sets of observations extending from July 3 to July 15, the following relative errors were found, the polar point being taken for the origin.

ARC.	ERRORS.	Z	ARC.	ERRORS.	Z
°	″	″	°	″	″
0— 30	+1.38	+ 1.38	180—210	− 2.49	+8.00
30— 60	+2.83	+ 4.21	210—240	—1.42	+6.58
60— 90	+2.92	+ 7.13	240—270	—2.90	+3.68
90—120	+1.41	+ 8.54	270—300	—3.58	+0.10
120—150	+1.73	+10.27	300—330	+0.03	+0.13
150—180	+0.22	+10.49	330—360	+0.13	+0.00

Some of accumulated errors at contact points from measures with microscope:

	Errors in Division of Micrometer Screw.	Error in Arc.		Errors in Division of Micrometer Screw.	Error in Arc
°	″	″	°	″	″
0— 30	.0	+0.0	180—210	+17.6	+1.5
30— 60	+ 1.6	+0.1	210—240	+11.2	+0.9
60— 90	+ 7.6	+0.6	240—270	+ 4.6	+0.4
90—120	+10.6	+0.9	270—300	+ 0.0	+0.0
120—150	+16.8	+1.4	300—330	— 1.2	−0.1
150—180	+18.8	+1.2	330—360	+ 0.0	+0.0

It will be seen that the general form of the two summed series is the same but they widely differ in the maximum value. It became at once obvious from this preliminary investigation that it would be necessary to grind the circle, upon which the magnet arm rests, to an exactly circular form. This was very successfully accomplished by Mr. CLARK in the following way: A slide rest carrying an emery wheel was firmly mounted nearly opposite the axis

of the instrument. The motion to the emery was given by means of an old-fashioned spinning wheel. The operation of grinding was conducted as follows:

One assistant turned the spinning-wheel, Mr. CLARK managed the slide rest, which governed the movement of the emery wheel, while I, at one end of the telescope, gave a nearly uniform motion in revolution with the aid of an assistant stationed at the other end. When the operation of grinding was completed, it was found that a complete revolution of the telescope could be made without the slightest trace of disturbance in the position of the magnet-arm under a microscope having twelve times the magnifying power of microscopes attached to the telescope.

Before proceeding to describe the new series of observations, it will be necessary to refer to the means employed to neutralize the momentum of the telescope produced by the shock of contact with the stops. It was found that the disturbance produced by contact made by a hand-movement of the arm, that there was a liability to a maximum error of about 3″. This amount was sensibly reduced by inserting a piece of writing paper between the arm and the stop, and then completing the movement by withdrawing the paper. The next experiment was with an air-buffer attached to the stop-plates, with which the initial contact was made; but it was found that the movement against the air-spring for the remaining distance to the stop was not sufficiently uniform, although there was a decided improvement over results previously obtained. A water-buffer was then employed; the water from a cylinder attached to the stop-plates being forced by a weight-pressure through a cylinder of small diameter. With this buffer as a momentum arrester, it appears from a long series of observations for contact, that the probable error of a single contact is about 0.03″ or about $\frac{1}{10}$ of the ordinary value for a single observation with four microscopes.

Eight sets of comparisons of the 30° divisions of the circle have already been made with the improved apparatus, with the following results:

CORRECTIONS.

DATE.	0—30	30—60	60—90	90—120	120—150	150—180
	"	"	"	"	"	"
July 28,	+0.22	+1.63	+1.43	−0.34	+0.64	+0.49
" 29,	+0.07	+1.47	+2.39	−0.36	+0.51	−0.57
" 30,	−0.15	+2.91	+2.49	+0.13	+0.48	−0.60
" 31,	−1.02	+3.00	+2.34	−0.79	−0.16	−0.38
Aug. 1,	−1.38	+2.03	+1.35	−0.84	+0.60	−0.35
" 1,	−0.19	+0.97	+0.96	−0.94	+0.45	+0.59
" 4,	−1.16	+0.61	+0.37	−1.10	+0.69	−0.29
" 4,	−1.16	+1.54	+1.46	−1.23	+1.02	−0.02

DATE.	180—210	210—240	240—270	270—300	300—330	330—360
	"	"	"	"	"	"
July 28,	−0.72	+0.74	−0.73	−1.53	−0.85	−0.98
" 29,	−0.84	+0.52	−0.95	−2.55	+0.38	−0.06
" 30,	−2.47	+0.10	−1.10	−1.87	+0.37	−0.43
" 31,	−1.10	+0.66	−1.00	−1.53	+0.62	−0.63
Aug. 1,	−0.63	+1.43	−0.50	−1.72	−0.19	+0.21
" 1,	−0.05	+1.36	−0.76	−1.74	−0.08	+0.40
" 4,	−0.04	+1.57	−0.15	−0.76	+0.30	−0.13
" 4,	−0.42	+1.06	−0.28	−1.90	+0.07	+0.26

Taking the means of the separate determinations of the 30° spaces we have:

Spaces.	Corrections.	Summed Series=z.	Spaces.	Corrections.	Summed Series=z.
0 — 30	−0.60"	−0.60"	180 — 210	−0.78"	+1.70"
30 — 60	+1.77	+1.17	210 — 240	+0.93	+2.63
60 — 90	+1.60	+2.77	240 — 270	−0.68	+1.95
90 — 120	−0.68	+2.09	270 — 300	−1.70	+0.25
120 — 150	+0.53	+2.62	300 — 330	−0.08	+0.17
150 — 180	−0.14	+2.48	330 — 360	−0.17	+0.00

It is the intention to continue the examination of the subdivisions of the circle throughout the coming year. The subdivision of the 30° spaces will be made by setting the stops for that number of subdivisions, which can be safely made at one time without danger of the introduction of errors depending on the temperature. With two assistants, one to read the 4 microscopes, and one to record, the examination of the 30° divisions can be completed in about $1^h\ 20^m$.

If it shall be conclusively shown from an investigation of the present graduations of the circle that this method will give greater accuracy than former methods of investigation, it is the purpose to produce a new set of graduations just inside of the original graduations.

In conclusion it may be said that an excellent test of the method will be had when the telescope is reversed and the errors of the other circle are determined. The errors of this circle have already been determined for each single degree by comparison with a graduated metal arc of 15° with which each 15° of the circle was compared.

EDITORIAL NOTES.

Volumes II and III of the MESSENGER can now be had complete in numbers or bound, as preferred. The price for unbound volumes is $2.00; for the bound in plain style, light or black, $2.75. Volume I can be supplied only on special order.

As most subscriptions end with this number, it will be a favor if our subscribers will promptly indicate to us whether or not the MESSENGER shall be continued for the year 1885. It is our purpose to discontinue it at once where it is not desired.

For the many, many letters of encouragement and appreciation, which the kindness of friends has prompted from many parts of this and other countries, we are especially grateful. In some ways it would be gratifying to publish extracts from correspondence of this kind, but we have refrained from it uniformly, because the object of such notices might be misunderstood.

The items of astronomical news of various kinds that have been furnished by many in the past, have been valuable to our readers as we have been repeatedly assured by professional workers. We desire to call attention again to this important matter, and to solicit, respectfully, from every one, brief statements of fact or news that may be worthy of general attention. The astronomer, like any one else in special lines of work, wishes to know what others are busied about, how they work and how they succeed. Sentences brief and to the point, if but few in number, will be worth many times their cost to individuals in the benefits they may confer on others.

It has been a pleasant surprise to notice how many clergymen of various names are found on our subscription lists. Some are observers, others are mathematicians and all apparently much interested in the progress of our science. This is natural, since astronomy furnishes one of the grandest of the scientific fields for the play of imagination, for illustration, for lessons in the higher law, so called. drawn from many of those mental operations of the skilled analyst, and the keen and watchful observer. The azure depths are full of the handiwork of ONE who has spoken the LIVING WORD

Those whose duty it is to care for clocks that regulate extensive railway or city time services, may find the little device in use at the observatory of Carleton College a convenient arrangement. The mean time clock is corrected almost daily by means of an electric current and two magnets. The current is directed and measured

(roughly) by the aid of a galvanometer and a commutator made neatly from a cheap pocket compass and a ring of wood, at a cost of about two dollars. By a turn of the index of the commutator a current of electricity magnetizes a temporary magnet and the pendulum of the clock is accelerated or retarded so gently that its common rate is disturbed only temporarily while the current is acting. Turn the index, and the current is reversed, and the opposite effect is produced on the clock pendulum, and the needle of the galvanometer always indicates to the eye of the observer which way the clock is being corrected, and how rapidly, by the number of degrees it is deflected from its zero position. It is very convenient, certain and surprisingly exact.

COMET BARNARD, 1884.

The following are the elements of the orbit of BARNARD'S comet computed by Dr. J. MORRISON of Washington, D. C.:

ELLIPTICAL ELEMENTS.

Epoch, 1884. Sept. 24.5, Washington Mean Time.

M =	7°	13′	19.″52	
π =	300°	57	44. 43	
ω =	5	11	23. 56	
i =	5	28	18. 94	
φ =	35	37	2. 59	Mean Equinox, 1884.0.
Log a =			0.4862043	
Log q =			0.1069968	
Log μ =			2.8207001	

Period=1958.4158 days.

	C—O. $d\lambda \cos \beta$	$d\beta$
Aug. 12.	+ 6″.52	−3″.21
Sept. 15.	+ 9″.85	−8″.09
Oct. 14.	+31″.(?)	+1″.4.(?)

This orbit was calculated from positions obtained July 25, August 24, and September 23.

The period given by Dr. MORRISON is 50 days less than that found by BERBERICK (SIDEREAL MESSENGER No. 29, p. 284).

My last observation of this comet before the October *Moon* interfered was on the night of October 24, when it appeared a mere glow in the field. It seemed scarcely possible that after the *Moon* withdrew the comet could be seen again. However on the night of Nov. 5, I made a search for it with my five-inch BYRNE refractor, and after close sweeping I found it. It lay less than one-half degree north and preceding the 5½ m. star B. A. C. 7722, and was excessively faint. An effort was made to see it with the six-inch equatorial, but from the rather contracted field it was not possible to glimpse it, the rising *Moon* probably preventing. Nov. 6 it was again detected with the five-inch, being small and most excessively

faint. It could not then be seen with the six-inch. From the fortunate fact that a small faint star was involved near the center of the comet, I succeeded in getting a position. Later, I once or twice faintly glimpsed the comet with the six-inch.

The night of Nov. 7 was clearer and the 'seeing' better. Found the comet with five-inch and could hold it steadily, though it was a great strain on the eye-sight. Tried it with six-inch; not seen at first, but afterwards by straining the eye it was feebly glimpsed, but it was impossible to hold it steady for a second at a time. In the five-inch could hold it quite steadily. Succeeded in getting comparison with 8 m. star, from which the comet's place can be obtained.

A comet eye-piece of some thirty diameters made by BAUSCH & LOMB, Rochester, was used on the five-inch; this, giving a field of about one and one-fourth degrees, gave more contrast than the six-inch.

To me these observations are conclusive proof that there are certain faint objects that may be seen in a comparatively small telescope which cannot be seen in large instruments. Apparently the comet, at the last three observations, has been the faintest object I have yet seen in the heavens. Should the weather prove good, I shall expect to follow it for some time yet.

It would be interesting to know how the comet appears in some of the large telescopes.

Vanderbilt University,
Nashville, Tenn.

E. E. BARNARD.

MINIMUM OF ALGOL.

Under date of Nov. 9, JOHN H. EADIE, Bayonne, N. J., says: "A minimum of *Algol* occurred this evening. At 7½ o'clock the light of the star was very dim, but not quite at a minimum. When I again saw it at $9^h\ 45^m$, it had considerably increased in brilliancy showing that a minimum had been reached between the times given."

The dates of minima given in the last MESSENGER were wrong as has also been kindly pointed out by Dr. T. D. SIMONTON of St. Paul. The above figures are in Paris time. The translator should have subtracted $5^h\ 17^m\ 33^s$ to give Washington time.

NOTE ON A SOUTHERN NEBULA.

A very large nebula was noticed at the Cincinnati Observatory on the evening of Oct. 18th. On looking for it in the catalogues the following curious facts were discovered. Although easily seen with a four-inch glass, it is not given by the HERSCHELS. It seems first to have been discovered by CAPOCCI at Naples, and by HARDING at Gottingen, about the year 1827. See *Astr. Nachr.* No. 120 and BODE'S *Astr. Jahrbuch* for 1827. CAPOCCI places it in R. A. 333° 30′; Decl. —21° 40′. HARDING in R. A. 334° 30′; Decl. —21° 45′.

In D'ARREST's catalogue of nebulæ for 1850 he remarks under R. A. 330° 50′; Decl. −21° 33′, "Announced as new by CAPOCCI, *A. N.* No. 120. This nebula, never observed since, I have looked for in vain in favorable nights. I think, therefore, the R. A. may be ten minutes too great and the nebula identical with H. II. 1 = *h*.2143. Position and description agree on this supposition."

In 1857 (*Astr. Nachr.* No. 1072) WINNEKE gives the position according to HARDING and remarks, "This nebula is in the catalogue of neither HERSCHEL. A large nebulous mass easily visible in the finder."

It is probable that D'ARREST looked for the nebula with too high a power. It is best seen with a power as low as 15. This may also account for its absence from the catalogues of the HERSCHELS. Its position for 1885, as determined here, is: R. A. $22^h\ 23^m\ 18^s$; Decl. −21° 26′. It is about five minutes west of *Mu Aquarii*.

Cincinnati Observatory, J. G. PORTER, Astronomer.

THE FIGURE OF THE PLANET URANUS.

Dr. SEELIGER, di ctor of the Munich Observatory, has employed the 10½-inch refractor (which has been remounted by the REPSOLDS in measures of the discs of the various planets. He employs a total reflecting prism back of the eye-piece and can therefore cause any diameter of the planet to appear at any angle with the vertical.

Measures of this kind have been made (on ten nights) on *Uranus* and Dr. SEELIGER's result is clearly against any ellipticity of the disc.

In this he disagrees with several late observers (SCHIAPARELLI, YOUNG and others) but agrees with the conclusions of LASSELL, BRUHNS, ENGELMAN and others. The question is not settled, in any event, but this latest result is interesting specially on account of the method employed, which avoids a dangerous kind of constant error.

ON A HITHERTO UNEXPLAINED OBSERVATION BY CAPT. GILLISS.

I desire to suggest a probable explanation of a hitherto unaccounted for observation of GILLISS' given in Vol. 6 of GOULD's *Astronomical Journal p.* 94. This was an occultation by the *Moon* observed at Santiago de Chile, 1852, Feb. 29, at $7^h\ 40^m\ 48.^s3$, local mean time of a star noted as 7.8 magnitude. This star could not afterward be recognized, although Mr. FERGUSON made a special and careful search in the region occupied by the *Moon* at that time, and found only stars of the 10th magnitude. GILLISS remarks that had it been possible to see a star so small as a 10th m., it certainly could not have been mistaken for one of 7.8 m., and moreover that it is more probable that the occulted star was doubtless obscured by cirrus clouds, and its magnitude under noted.

The suggestion I have to make is that this was an occultation of

the star *Eta Geminorum*, although this explanation is so obvious that it is strange it should not have occurred to Capt. GILLISS or Professor FERGUSON. Perhaps some reader of the SIDEREAL MESSENGER may have the time and inclination to settle the point by calculation. It may be added that *Eta Geminorum* is a variable; although, of course, the limits (3.2—4.2 m.) are too narrow to have any bearing on the question.

S. C. CHANDLER, JR.

Cambridge, Mass.,
Oct. 31st, 1884.

ELEMENTS OF BARNARD'S COMET.

(Communicated by Commodore S. R. FRANKLIN, U. S. N., Sup't Naval Observatory, Washington.)

The following Elements of Barnard's Comet of 1884 have been computed by Professor E. FRISBY, U. S. N., from observations made at the Naval Observatory, on the evenings of August 12, September 15, and October 20:

	Wash. M. T.				App α			App δ		
		h	m	s	h	m	s	°	′	″
Aug.	12.	8	40	46.8	17	2	49.31	− 36	43	2.4
Sept	15.	9	48	7.0	19	21	1.09	− 29	32	35.2
Oct.	20.	7	9	32.5	21	20	25.05	− 17	5	58.9

From which are derived the following elements:

Time of Perihelion passage August 16.289528 Gr. M. T.

		°	′	″	
ω	=	5	23	51.2	Mean Equinox
$\pi-\omega$	=	300	46	18.2	
i	=	5	24	48.7	
φ	=	34	51	49.3	1684.0
$\log a$	=	0.474164			

$$\mu = 689.858''$$

Period = 1878.65 days.

Comparison with the middle place gives

$$\delta\lambda \cos\beta = +2.6''$$
$$\delta\beta = -0.6''$$

$$x = [9.999983]\, r \sin(36\ 8\ 43.2 + v)$$
$$y = [9.942476]\, r \sin(306\ 25\ 31.6 + v) \quad 1884.0$$
$$z = [9.683488]\, r \sin(305\ 13\ 19.9 + v)$$

M. VAN DER VEN has printed in the *Archives du Musee Teyler* (series II., parts 1, 2) an examination of a universal instrument made by the REPSOLDS for the Musee Teyler. This paper is of interest on account of the full details of the observations, which are given, and the complete way in which the sources of error have been traced.

OBSERVATIONS OF COMET BARNARD, 1884, MADE AT THE CINCINNATI OBSERVATORY.

1884.	Mt. Lookout Mean Time.			App. R. A.			Log. $p.\,\Delta$	App. Decl.			Log. $p.\,\Delta$	No. of C'mp	C'mp Star.
	h	m	s	h	m	s		°	′	″			
Sept. 17,	7	46	09	19	29	01.26	8.204					6	1
" 17,	8	21	18					− 28	53	40.5	0 910	12	1
" 18,	7	27	01	19	32	33.36	8.398	− 28	34	04.5	0.912	14. 8	2
" 20,	8	43	11	19	40	29.85	9.155	− 27	51	58.8	0.903	10. 6	3
Oct. 14,	9	24	46	21	03	02.67	9.379	− 19	10	30.4	0.894	16.10	4
" 15,	7	45	44	21	05	51.65	8.619	− 18	50	28.0	0.874	10.10	5
" 16,	9	48	30	21	09	04.64	9.446	− 18	27	32.3	0.899	10. 8	6
" 18,	8	20	06	21	14	49.91	9.265	− 17	46	11.5	0.878	10.10	7

Star	Mean R.A. 1884.0			Red to App.	Mean Decl. 1884.0			Red to App.	Authority.
	h	m	s	s	°	′	″	″	
1	19	28	48.10	+ 3.56	−28	55	15.2	+ 13.0	[8374) ½ (O. Arg. 19737-8 + Yar.
2	19	32	38.28	+ 3.54	−28	32	44.7	+ 13.3	2 Comp. with O. Arg. 19660
3	19	37	11.42	+ 3.51	−27	54	57.3	+ 13.7	½ (O. Arg. 19901 + Yar. 8462)
4	21	02	16.64	+ 3.26	−19	11	36.6	+ 19.6	O. Arg. 21151
5	21	03	59.94	+ 3.22	−18	48	01.6	+ 19.6	O. Arg. 21183
6	21	11	26.56	+ 3.24	−18	28	15.0	+ 19.9	Newcomb 947
7	21	11	46.13	+ 3.19	−17	56	49.5	+ 20.0	O. Arg. 21282

During September the comet was bright with a well-defined nucleus. In October it was large and faint, with no appreciable condensation, and the observations were correspondingly difficult and uncertain. The filar micrometer was used throughout, except for the last observation, which was made with a scale micrometer.

Professor WILSON observed in October; myself in September.

J. G. PORTER, Astronomer.

Cincinnati Observatory.

KRAKATOA ASHES.

The following interesting note respecting the eruption from the volcano of Krakatoa in August, 1883, is from a private letter from ALFRED BICKNELL, Boston, Mass.:

"At the date of the eruption the bark 'Wm. H. Bessie,' of Boston, a vessel of 1,100 tons, was in the Straits of Sunda, on her passage from Batavia. My informant, S. GIBBS, was then mate—now master of the bark. He said they were twelve to fifteen miles in a direct line from Krakatoa when the eruption began, and it soon became too dark to run from the shower of ashes. Being in twenty-five fathoms, they lay with anchors down for over forty-eight hours, and until it was light enough to see. During most of the time the darkness was so great, that at noon the hand could not be seen within a few inches of the eye. The ashes fell in such enormous quantities that all hands were constantly engaged in shoveling them overboard, as well as they could in the darkness. The sea was not "rough," but a tre-

mendous current was running. As soon as they could see at all, they weighed anchor, and found the ashes on the surface of the ocean 600 miles away. They kept a few barrels for scouring, but on their arrival here last December I went to the vessel and procured a quantity. The "Bessie" was probably as *near* the volcano as any one that escaped unharmed, and for many hours they were in momentary expectation of being overwhelmed by the eruption."

Mr. BICKNELL favored the MESSENGER with a specimen of the ashes. They are fine, heavy and gray in color, closely resembling marl.

SATELLITES OF SATURN.

Professor A. HALL, Naval Observatory, Washington, D. C., kindly offers the following important note:

"The ephemerides of the satellites of *Saturn*, given by Mr. A. MARTH in the June number of the Notices of the Royal Astronomical Society, are nearly correct, and will be found very convenient in use. This is especially the case for the faint satellites *Mimas and Hyperion*. This is the first year for which a good ephemeris of *Hyperion* has ever been given."

WOLF'S COMET.

Observations of the comet Wolf have been made with the nine-inch reflector upon every suitable occasion, mainly as a study of its physical characteristics. The changes in form and brightness have been numerous and interesting. My first observation was made on September 25, when it was an easy telescopic object in moderate moonlight. The nucleus was small and star-like, the coma large, tolerably well defined and elliptical in outline, the major axis in a line with the Sun.

Wolf's Comet, by Brooks.

I append two drawings of the comet made on the evenings of Oct. 11th and 14th, respectively. On October 11th, the nucleus was small, hard and well defined, and a stumpy brush-like tail was seen with

close attention, pointing from the *Sun*. On the 14th inst. the appearance of the comet had changed very much; the nucleus being larger and more nebulous, while the form of the tail was that shown in the second sketch. These features were faint and delicate and best seen with magnifying powers of sixty and eighty. Eye-pieces giving a flat field and black sky ground are needed for this class of work. On November 9th the comet appeared to me much fainter than it should be theoretically, and the ill-defined central condensation was mottled, presenting the appearance of a faint star-cluster when viewed with a power too low to resolve it.

Red House Observatory,
Nov. 13th, 1884. WILLIAM R. BROOKS.

EASY STUDIES OF THE CONSTELLATIONS.

These notes are for those who know little about the face of the sky, as it appears from night to night, but wish to know more; those who have an interest in the elements of astronomy and would like to use their eyes and give careful attention to what they see, though they have no good star-atlas or even an opera-glass to aid them in these plain observations. Very much can be done in the way of self-instruction if the common observer will give attention to what he sees and form the habit of writing down the substance of what has been seen. It is quite useless to try to remember almost anything that one wishes to reproduce accurately. Definite notes must be taken at the time and while the object is before the eye if a person wishes to be sure of what he has seen, or to have any real value attach to his ideas in the future.

Now, with note-book in hand the young observer wishes to begin a half-hour study of the sky, on any clear night at 10 or 9 o'clock respectively, on the first or fifteenth of the present month.

Facing the north, the observer will remember that the geographical latitude of his place is equal to the altitude of the Pole of the celestial sphere which is closely marked by *Polaris* or the North Star. In latitude 45° north, for example, this star would appear to be 45° in altitude from the north point of the horizon, or half way to the zenith. A line drawn from the north point of the horizon through *Polaris*, the zenith, and the south part of the horizon is the Prime Meridian. The constellation of *Ursa Major*, the Great Bear consisting of seven stars about as bright as *Polaris*, and forming a figure like a dipper is seen passing the meridian from west to east, in the latitude supposed, less than half way from the horizon to the North Star. Two bright stars on the right form a line with the North Star and are called the Pointers, because by them a person may always quickly locate *Polaris* at night if the points of the compass are uncertain.

The next point of interest is their names and distances from each

other. The eight stars spoken of are all nearly of the same brightness and the Pointer nearest the Pole ($28\frac{3}{4}°$ distant) is called *Dubhe*, the other *Merak*; distance between them about 5°; west 8°, in bottom of the Dipper, is *Phegda*, north nearly $4\frac{1}{2}°$ is *Megrez*, next in handle is *Alioth*, $5\frac{1}{2}°$, then *Mizar* and *Alcor*, a neat naked-eye double star, in the bend of the handle and $4\frac{1}{2}°$; and finally *Benetnash*, 7°. This last distance is accurate enough to be used as a scale to practice measuring distances in the heavens. Note that and use it.

Observe when the Pointers are passing the meridian exactly below the *Polaris* and then observe them one hour later and so practice in telling time by the stars.

SUN-SPOTS.

The long-delayed maximum of solar spots, now undoubtedly passed, has attracted universal attention to the spot-periodicity. To-day and yesterday the visible hemisphere of the sun was, for the first time in nearly fourteen months, observed to be entirely free from spots; the occasion next preceding this being 1883, Sept 25. During the past two years, the only additional days on which the sun was observed to be without spots were, 1882, Oct. 9 and Dec. 3, and, in 1883, Feb. 23, and May 25, 26, 27, and 28.—*Science*. Nov. 14. DAVID P. TODD.

Mr. E. F. SAWYER, Cambridgeport, Mass., saw only two meteors from the *Leonids* Nov. 13, 14, 15, during a watch of $1^h\ 40^m$. They were as faint as a 5th m. star. It was thought that the Earth passed through the lower part of the stratum.

Subscriptions and orders not previously acknowledged: James Jackson, Paterson, N. J.; Reading Room, Washington, and Jefferson College, Washington, Penna.: D. Stock, M. D., Federal St., Camden, N. J.; Library of Johns Hopkins University, (Vols. I, II, III,) Baltimore, Md.; John M. Black, 1334 Chestnut Street, Philadelphia, Pa.; Aaron B. Chapman, 183 Portrea St., New Haven, Ct.; Robert Elliott. Hannibal, Mo.

BOOK NOTICE.

Vierstellige Logarithmer von F. W. REX: J. B. METZLER. Stuttgart, 8 vo. pp. 64.

This is the best four-place logarithm-book which has ever fallen under the writer's eye. The logarithms of the trigonometric functions are given for each 10′: from 2° to 12° log. sin. and log. tan. are given for each tenth of a minute, and from 0° to 2° for each tenth of a minute. There are tables of addition and subtraction logarithms, Napierian logarithms, squares, cubes, chords, etc. The tables of proportional parts are very full. The type is large and plain, and the paper excellent. H. A. H.